Naval Ocean Systems Center
San Diego, CA 92152-5000

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The Arctic Environmental Facilities:

NAVAL OCEAN SYSTEMS CENTER
San Diego, California 92152-5000

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ADMINISTRATIVE INFORMATION

This document was prepared in response to requests for further information on the testing services available at the Arctic Environmental Facilities of the Arctic Submarine Laboratory.

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INTRODUCTION

The Arctic first became an area of interest to the Navy in the late 1940s when USAF bombers were expected to fly across the Arctic Ocean in the event of hostilities with the Soviet Union. Patrol submarines would then be expected to serve as "lifeguards" by rescuing fliers downed in the Arctic Ocean. The Navy, however, knew little about these extremely inhospitable waters. The ice canopy appeared to present an insurmountable barrier to both surface ships and air-breathing diesel-electric submarines. Also, the skills necessary to handle submarines in the open ocean differed greatly from the skills necessary to dive, surface, and clear obstacles under the ice.

To investigate such arctic-related problems, researchers at the Navy Electronics Laboratory (NEL), a predecessor of today's Naval Ocean Systems Center (NOSC), began to test existing sonars for use in underice piloting. NEL researchers also developed methods for interpreting the data generated by sonars so that submarines could safely penetrate short distances beneath the arctic ice.

In addition, NEL researchers, like their World War II precursors, accompanied the submarines to instruct submariners in using NEL-developed equipment, to evaluate its performance, and to pinpoint problems that showed up in the field. To support these summer expeditions year-round, NEL began in the late 1940s to convert an unused U.S. Army coastal defense mortar battery, Battery Whistler, into the Deep Submergence Laboratory. This site would be used for testing the effects of seawater and different water pressures on materials and devices intended for use by submarines. Known subsequently as the Submarine Research Facility, it became the Arctic Submarine Laboratory in 1969. The present-day Arctic Environmental Facilities located here offer unique and extensive capabilities for work related not only to submarines but also to surface ships and commercial research, development, test, and evaluation projects that require a true arctic environment.

WHAT WE CAN PROVIDE

The Arctic Environmental Facilities at the Naval Ocean Systems Center offer year-round availability. The facilities meet DoD physical security requirements, and a staff consisting of personnel with arctic field experience can provide 24-hour test oversight. Along with the testing facilities detailed in the next section, the following support facilities are located on the site:

- Physics Lab
- Chemistry Lab
- Optics Lab
- Electronics Lab
- Dark Room
- Machine Shop

The Director heads NOSC's Arctic Submarine Laboratory, and NOSC scientists have assisted the Fleet in developing both hardware and operational doctrine. Staff personnel have supported numerous submarine patrols by collecting and analyzing environmental data, providing technical direction for exercises, instructing submariners in operating in the Arctic, designing and testing hardware for arctic applications, and analyzing data collected on arctic deployments.

ARCTIC ENVIRONMENTAL FACILITIES

ARCTIC EXPERIMENTAL ICE POOL

The Arctic Experimental Ice Pool is the only one of its kind in the Western Hemisphere that can grow true sea ice in the same manner as the Arctic and under predictable and controlled conditions. Totally refurbished in 1986/87, the pool holds approximately 250,000 gallons of Pacific Ocean sea water. The refrigeration plant uses ammonia to chill methylene chloride, and the overhead cooling coils simulate atmospheric conditions that freeze sea ice and permit sea ice to be grown in the same manner as in the Arctic Ocean. Fans can replicate wind conditions, and the pool can achieve and maintain –40°C (≈–40°F).

The pool is a well-insulated, steel-lined basin 78 feet long by 28 feet wide by 16 feet deep. A deionizing plant allows fresh water to be added to dilute the salinity of the San Diego seawater, so that the pool simulates the seasonal variations in salinity caused by melting pack ice at different times of the year in the Arctic Ocean.

An instrumented impact vehicle (figure 1) can be raised to impact the ice at different speeds; engineers can thus model the physical effects of surfacing through ice. The impact vehicle, which measures 37 feet long with a 3-foot diameter, is stored in a pit that is 50 feet deep and isolatable from the pool. The vertical velocity of the vehicle can be controlled by buoyancy. In the 1960s, the pool and impact vehicle were used for a series of experiments that provided guidance for establishing the Navy's vertical ascent rate for submarines surfacing through the water. Staff researchers are currently developing procedures for emergency surfacing through the ice by submarines. The ice pool has also been used for experiments to measure acoustic scattering from ice and light transmission through ice.

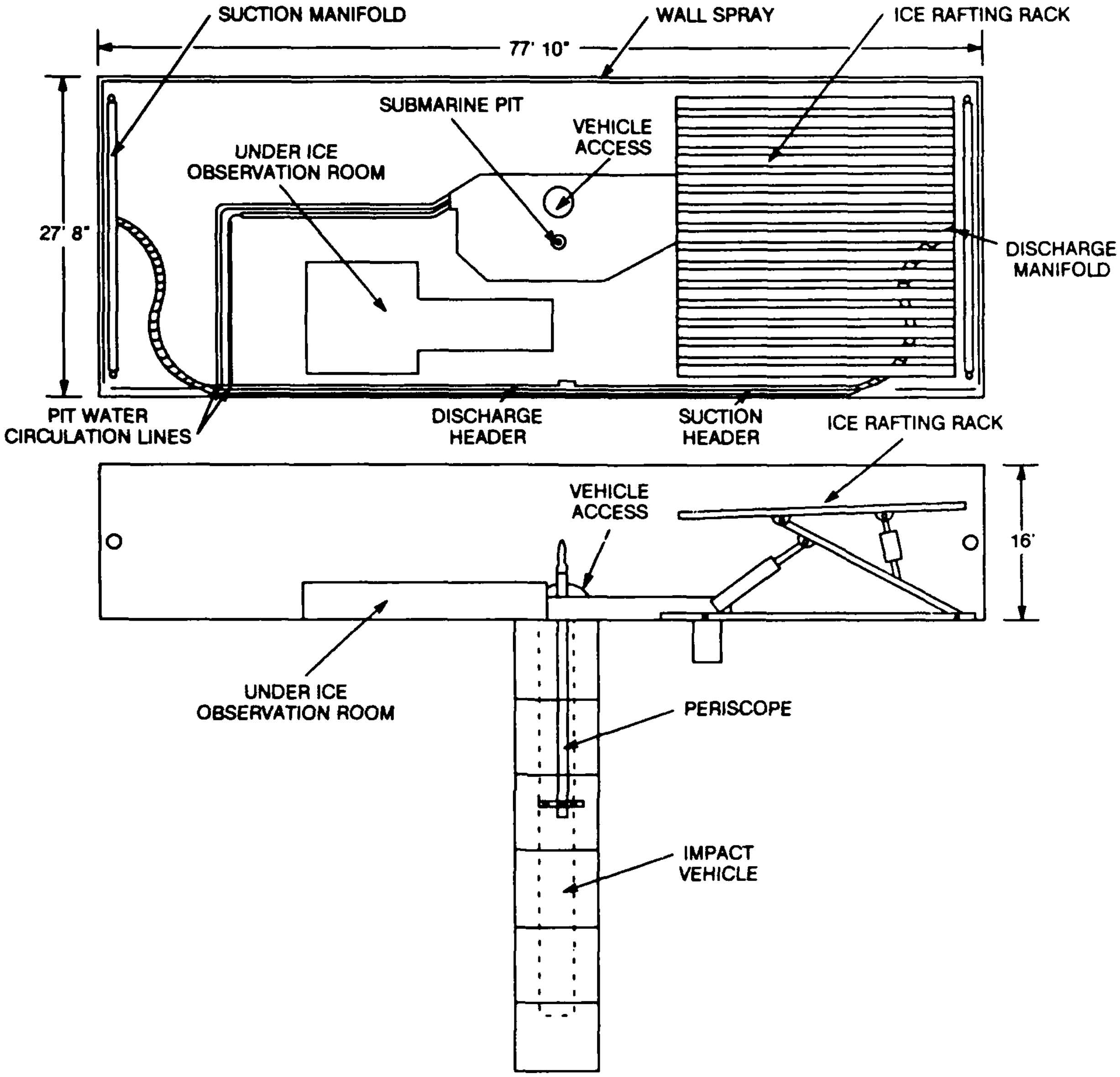


Figure 1. Arctic experimental pool.

The Arctic experimental ice pool can grow up to 5 feet of ice in one sheet. Figure 2 illustrates the length of time it takes to grow the ice in air temperatures ranging from –40°C to –20°C. In addition, ice sheets can be rafted to accelerate the formation of thick ice sheets. The ice pool features an underwater control booth with observation windows. There is also an installed periscope and multiple video camera equipment both above and below the ice.

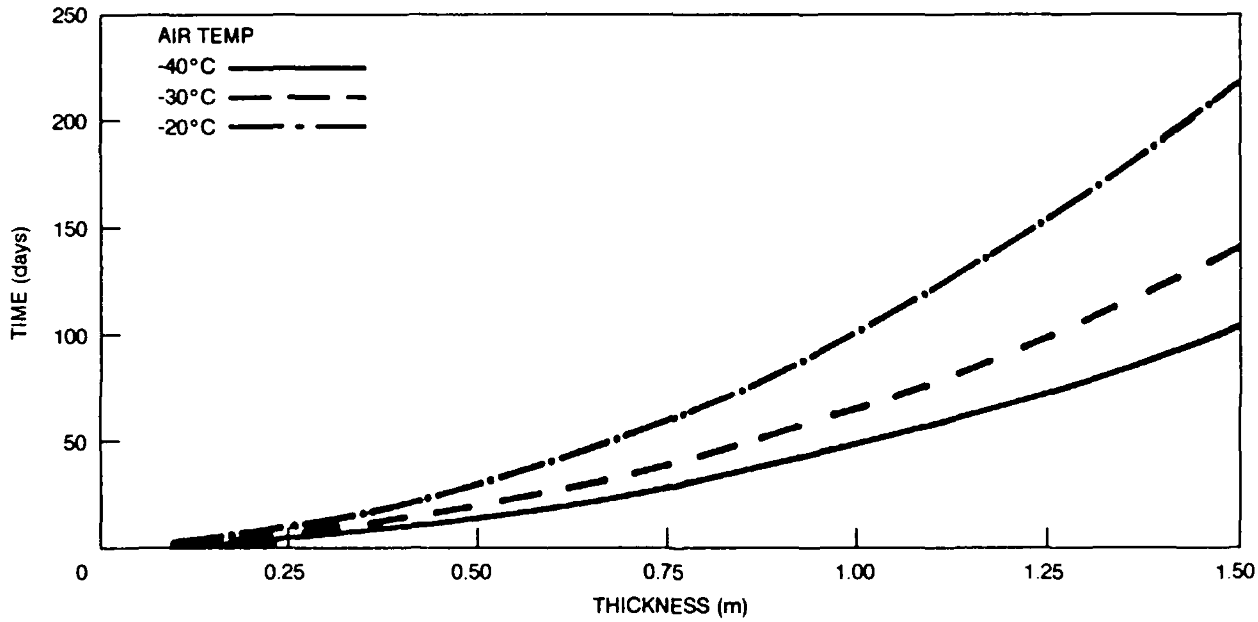


Figure 2. Growth rate of ice sheets.

SEA ICE CRYOSTAT MODELING BASIN

Another test facility available for use is the cryostat modeling basin, a 100-feet-long by 30-feet-wide by 50-inches-deep basin that can be filled with sea water, fresh water, or "doped" fresh water (figure 3). An air temperature of −20°C can be sustained, and air and water temperatures can be continuously monitored. A surface hydraulic towing bridge allows modeling of a surface ship's hull, and an underwater hydraulic sled allows modeling of impact from beneath the surface. The facility features also include a hydraulic large-entry lift and a cross trolley to enable multiple tests on the same ice sheet. Observation windows provide researchers with a view of the bottom of the ice sheet to within a few inches.

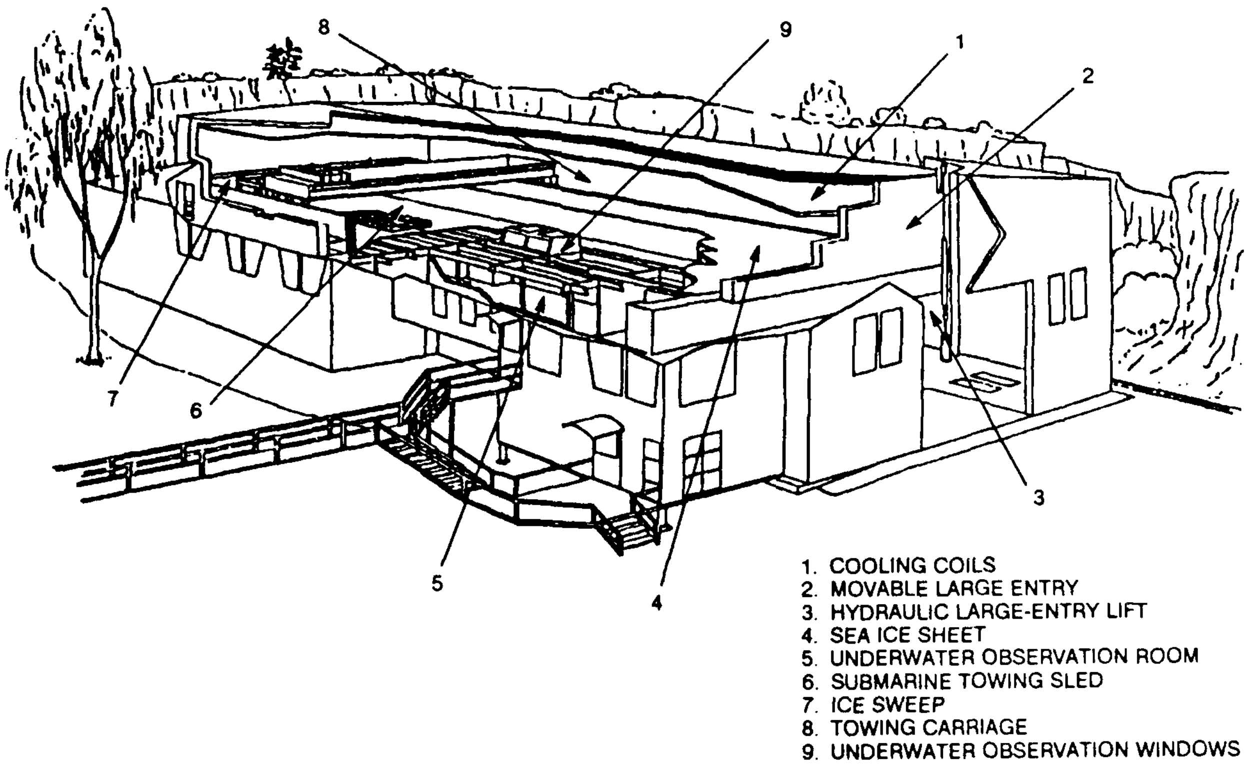


Figure 3. Sea ice cryostat modeling basin.

LARGE-ENTRY COLD CHAMBER

This facility (figure 4) can be used for tests requiring a dry, cold laboratory space. Designed with an inner area lining of stainless steel, the chamber measures 32 feet by 18 feet wide. Large-access double doors provide an entryway 12 feet high by 14 feet wide. The cold chamber floor can support 500 pounds per square feet and can sustain –45°C. The Marine Corps used this facility to test the LVT (landing vehicle, tracked) at –45°C for a 2-week period.

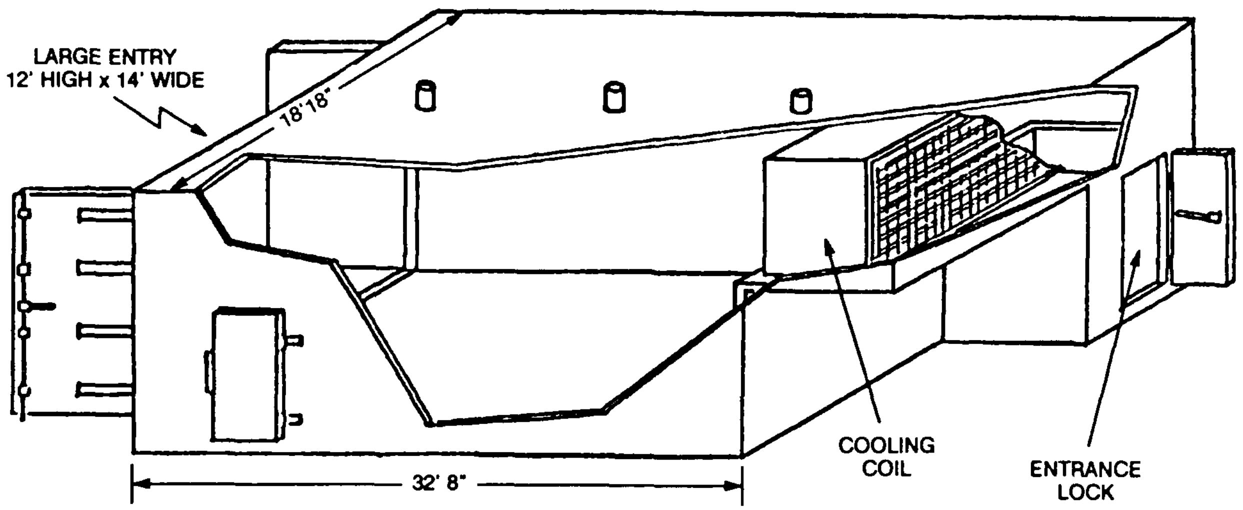


Figure 4. Large-entry cold chamber.

DRY COLD LABORATORIES

Two independently cooled dry cold laboratory spaces are available at the Arctic Environmental Facilities. The Northern Laboratory measures 10 feet by 12 feet, and the Southern Laboratory measures 12 feet by 16 feet (figure 5). Access doors open to 78 inches high by 40 inches wide. Air temperature can be continually monitored, and –45°C can be sustained.

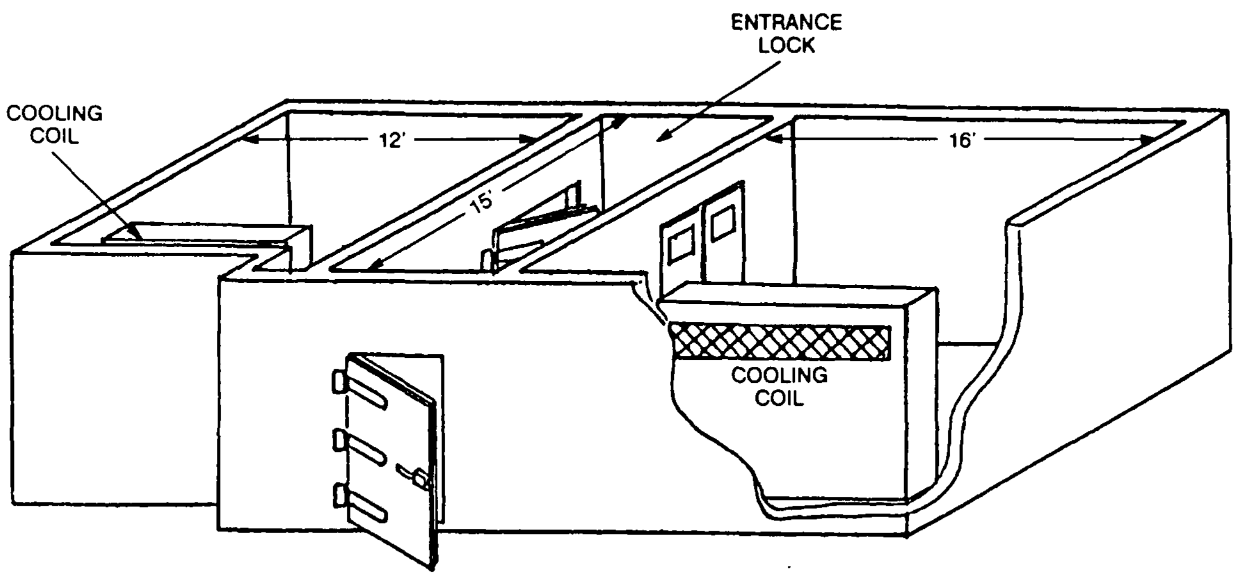
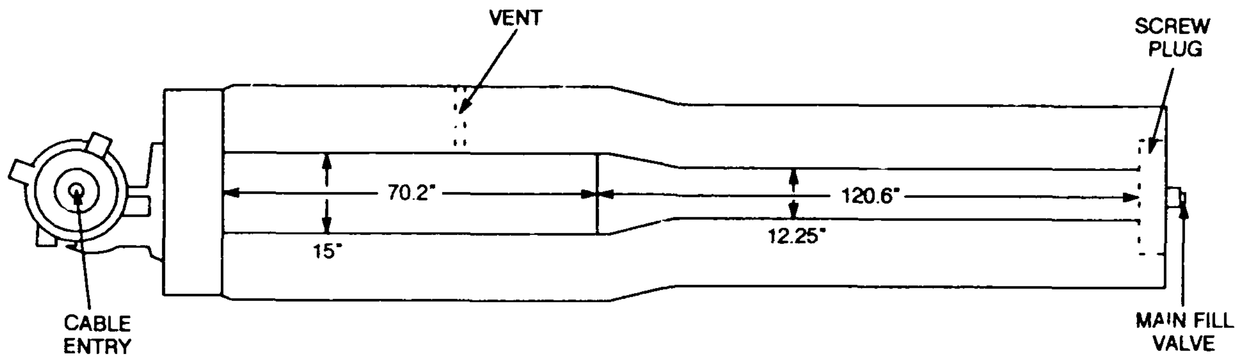


Figure 5. Dry cold laboratories.

PRESSURE TEST EQUIPMENT

Two cylindrical pressure chambers are available for those tests requiring a capability of 50,000 psi. One chamber measures 16 feet long with a 12-inch diameter; the other is 12.8 feet long with a 16-inch diameter (figure 6).



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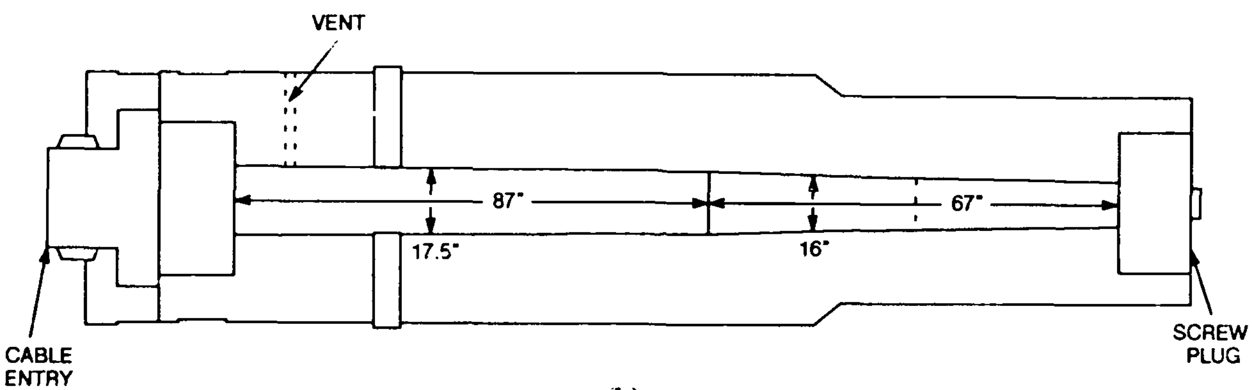

(b)

Figure 6. Pressure test equipment (50,000 psi).

Another facility, rated at 10,000 psi, can be operated over ranges from 0°C to 90°C. This pressure test facility is actually a tank that is 10 feet deep with a 5-foot diameter (figure 7).

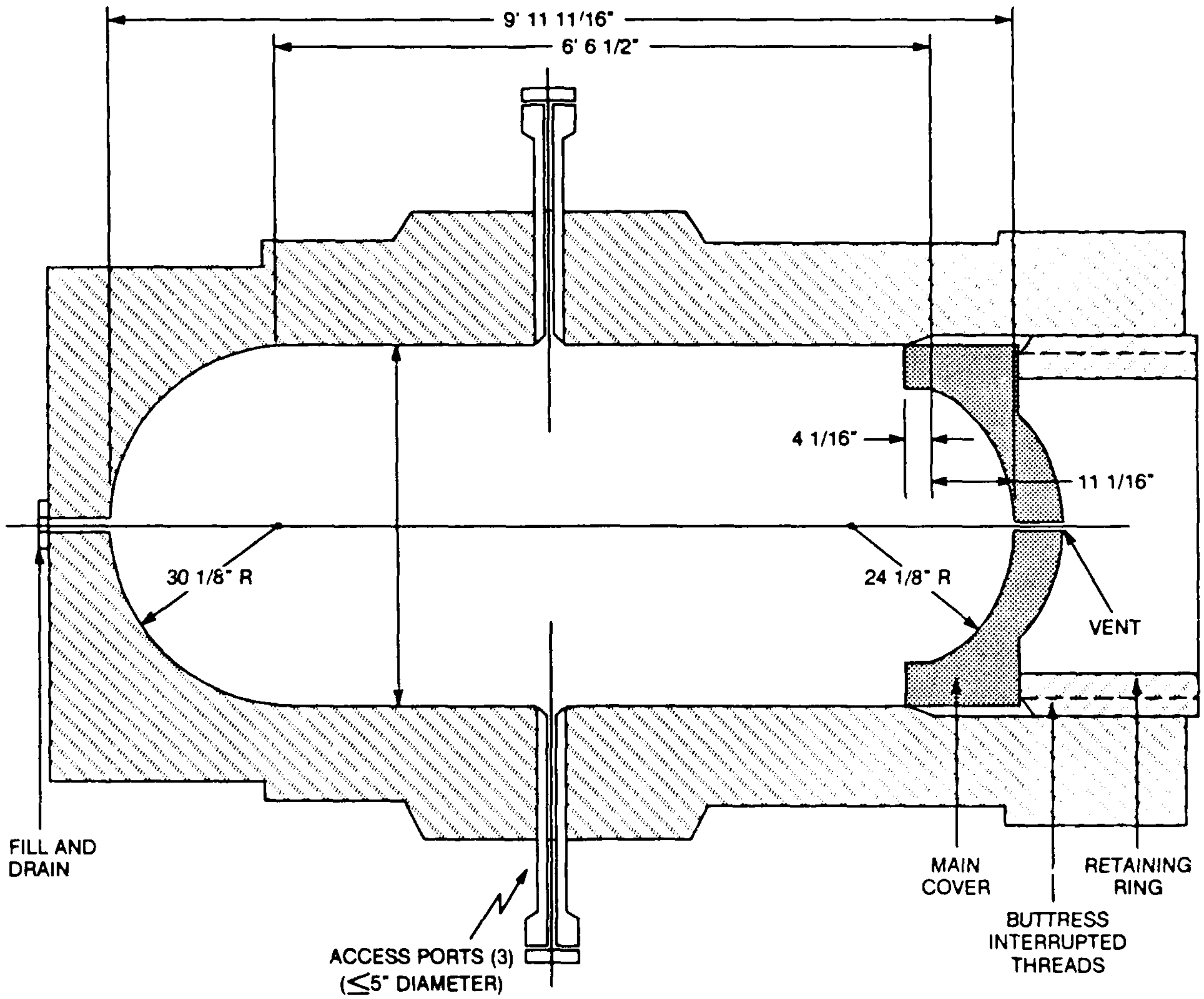

Figure 7. Pressure test equipment (10,000 psi).

A second tank, rated at 1,500 psi, can be cooled to 2°C while under pressure. This tank is 23 feet deep with a 30-inch diameter (figure 8).

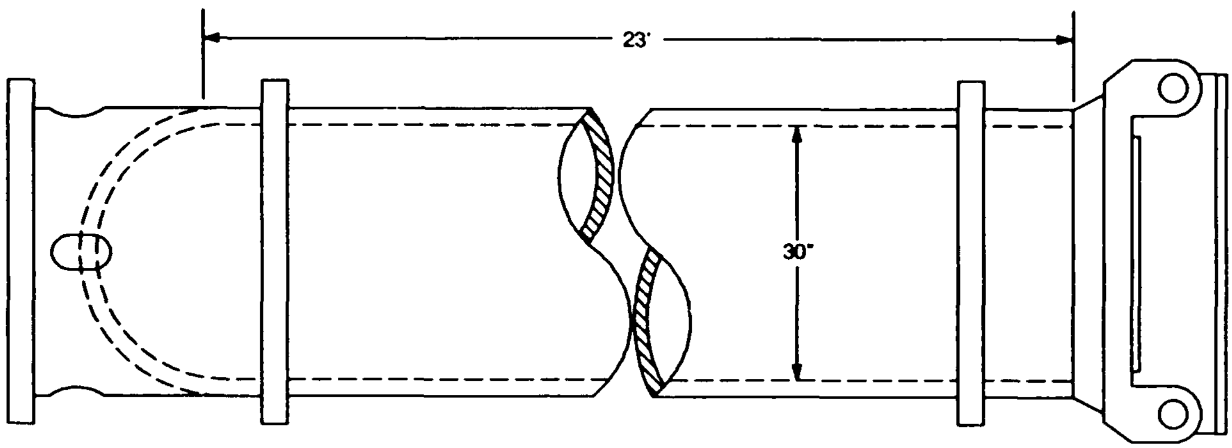

Figure 8. Pressure test equipment (1,500 psi).

A third tank, rated at 1,000 psi, is also available for pressure testing and measures 9 feet deep with a 54-inch diameter (figure 9).

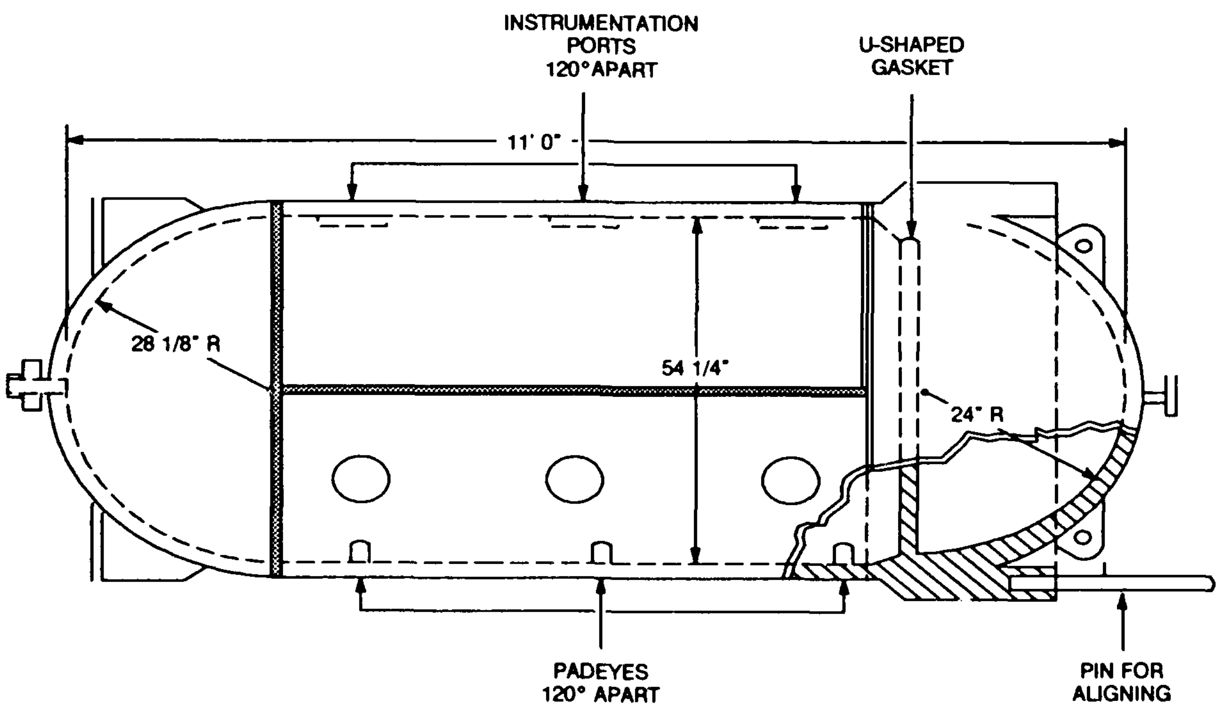

Figure 9. Pressure test equipment (1,000 psi).

SEA WATER POND AND POND ROOM

For those projects that study how sea ice is initially formed, NOSC designed and operates the sea water pond and pond room (figure 10). The pond is 6 feet wide by 8 feet long by 4 feet deep and has four observation windows. This facility also features a dry cold room that can be used for experiments and cold storage.

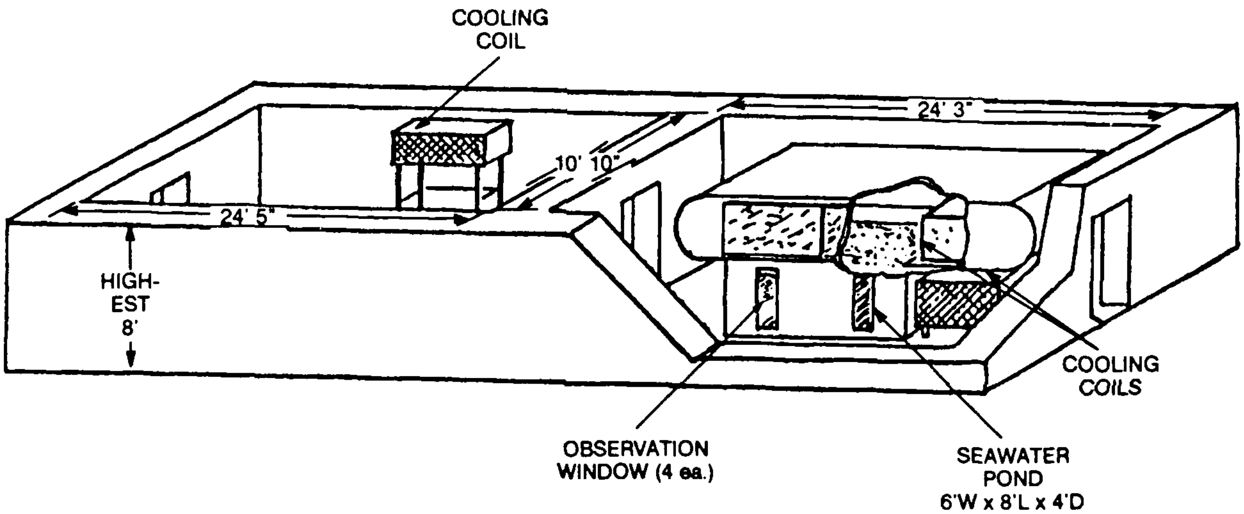

Figure 10. Sea water pond and pond room.

TYPES OF TESTING

A variety of tests can be performed at NOSC's Arctic Environmental Facilities. Typical tests include

- Pre-field/proof of concept tests
- Ice penetration methods (above and below)
- Sonar performance under ice
- Through-ice transmission measurements (laser/HF/acoustic/IR)
- Ice physics tests
- Ice fracture mechanics tests
- Ice thickness measurement systems
- Ice movement effects
- Sea water salinity variation tests
- Long-term cold soaking of equipment
- Component strength measurements versus ice
- Geophone performance
- Remotely operated vehicle (ROV)/operation underice (SHT)/hull coating abrasion tests
- Structure atmospheric icing effects

USER COSTS

User costs for the primary facility, the Arctic Experimental Pool, could vary with the tasking required. Full 24-hour test oversight by a staff with arctic field experience equates to a user cost of $3,200 per day.

Other facilities and services are provided and priced on the basis of user requirements. Work requests/funding documents for the estimated project cost are normally received at NOSC, Code 19, the scheduled date of the experiment.

SCHEDULING PROCEDURE

- A Statement of Work (SOW) must be submitted that includes the following information:
    1. Time required for each test run
    2. Total number of test runs
    3. Ice thickness required
    4. Destructive testing (yes/no)
    5. Ice area required (square feet)
- Also, a test plan must be submitted when the complexity of the test warrants it.
- Remember to include the date/timeframe desired for the test.
- Provide a Point of Contact.
- *State special equipment needed.*
- State special services required.

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REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1 AGENCY USE ONLY *(Leave blank)*	2 REPORT DATE	3. REPORT TYPE AND DATES COVERED
	May 1990	Final

4 TITLE AND SUBTITLE

ARCTIC ENVIRONMENTAL FACILITIES:
Test Capabilities

5. FUNDING NUMBERS

In-house funds

6 AUTHOR(S)

7 PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

Naval Ocean Systems Center
Code 19
San Diego, CA 92152-5000

8 PERFORMING ORGANIZATION REPORT NUMBER

NOSC TD 1728

9 SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

11 SUPPLEMENTARY NOTES

12a DISTRIBUTION/AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

12b. DISTRIBUTION CODE

13 ABSTRACT *(Maximum 200 words)*

This document describes the test equipment available at the Naval Ocean Systems Center's Arctic Environmental Facility. Ice can be grown to a thickness of 5 feet and arctic temperatures can be sustained. Types of testing are described as are user costs and scheduling procedures.

14 SUBJECT TERMS

arctic testing
sea ice
through-ice transmission
ice thickness
icing effects
sea water salinity

15 NUMBER OF PAGES

19

16 PRICE CODE

17 SECURITY CLASSIFICATION OF REPORT	18 SECURITY CLASSIFICATION OF THIS PAGE	19 SECURITY CLASSIFICATION OF ABSTRACT	20 LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	SAME AS REPORT